AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions and listings of claims in the application:

LISTING OF CLAIMS:

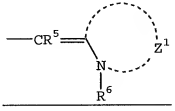
1. (currently amended): A two-photon absorbing polymerization method comprising: a first step of irradiating light on a composition comprising a free radical polymerizable compound capable of a two-photon absorption to form only a latent image; and a second step of exciting the latent image by an application of heat to cause a polymerization,

wherein as a two-photon absorbing compound, a cyanine dye, a merocyanine dye, an oxonol dye, a phthalocyanine dye or a compound represented by the following formula (1) is used:

Formula (1):

$$X^2-(CR^4=CR^3)_m-C(=O)-(CR^1=CR^2)_n-X^1$$

wherein R^1, R^2, R^3 and R^4 each independently represents a hydrogen atom or a substituent and some of R^1, R^2, R^3 and R^4 may combine with each other to form a ring; n and m each independently represents an integer of 0 to 4 and when n and m each is 2 or more, multiple R^1s, R^2s, R^3s or R^4s may be the same or different, provided that n and m are not 0 at the same time; and X^1 and X^2 each independently represents an aryl group, a heterocyclic group or a group represented by formula (2):



wherein R^5 represents a hydrogen atom or a substituent, R^6 represents a hydrogen atom, an alkyl group, an alkenyl group, an aryl group or a heterocyclic group, and Z^1 represents an atomic group for forming a 5- or 6-membered ring.

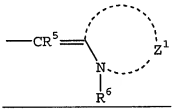
2. (currently amended): A ~~The~~ two-photon absorbing polymerization method ~~as claimed in claim 1~~ comprising: a first step of irradiating light on a composition comprising a cationic or anionic polymerizable compound capable of a two-photon absorption to form only a latent image; and a second step of exciting the latent image ~~wherein the excitation in the second step is performed~~ by ~~at least one of~~ an irradiation of light ~~and an application of heat~~ to cause a polymerization,

wherein as a two-photon absorbing compound, a cyanine dye, a merocyanine dye, an oxonol dye, a phthalocyanine dye or a compound represented by the following formula (1) is used:

Formula (1):

wherein R^1, R^2, R^3 and R^4 each independently represents a hydrogen atom or a substituent and some of R^1, R^2, R^3 and R^4 may combine with each other to form a ring; n and m

each independently represents an integer of 0 to 4 and when n and m each is 2 or more, multiple R^1s, R^2s, R^3s or R^4s may be the same or different, provided that n and m are not 0 at the same time; and X^1 and X^2 each independently represents an aryl group, a heterocyclic group or a group represented by formula (2):



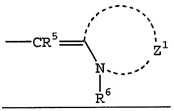
wherein R^5 represents a hydrogen atom or a substituent, R^6 represents a hydrogen atom, an alkyl group, an alkenyl group, an aryl group or a heterocyclic group, and Z^1 represents an atomic group for forming a 5- or 6-membered ring.

3. (currently amended): A two-photon absorbing optical recording method comprising: a first step of forming a latent image of a color-forming material comprising a cationic or anionic polymerizable compound by a two-photon absorption; a second step of irradiating light on said latent image of a color-forming material to cause a polymerization based on a linear absorption of the color-forming material; and thereby forming difference in the refractive index to perform a recording,

wherein as a two-photon absorbing compound, a cyanine dye, a merocyanine dye, an oxonol dye, a phthalocyanine dye or a compound represented by the following formula (1) is used:

Formula (1):

wherein R^1, R^2, R^3 and R^4 each independently represents a hydrogen atom or a substituent and some of R^1, R^2, R^3 and R^4 may combine with each other to form a ring; n and m each independently represents an integer of 0 to 4 and when n and m each is 2 or more, multiple R^1s, R^2s, R^3s or R^4s may be the same or different, provided that n and m are not 0 at the same time; and X^1 and X^2 each independently represents an aryl group, a heterocyclic group or a group represented by formula (2):



wherein R^5 represents a hydrogen atom or a substituent, R^6 represents a hydrogen atom, an alkyl group, an alkenyl group, an aryl group or a heterocyclic group, and Z^1 represents an atomic group for forming a 5- or 6-membered ring.

4. (original): The two-photon absorbing optical recording method as claimed in claim 3, wherein in said second step, light is irradiated on said latent image of a color-forming material to cause a polymerization while self-sensitizing and self-amplifying based on a linear absorption of the color-forming material and thereby difference in the refractive index is formed to perform a recording.

5. (currently amended): A two-photon absorbing optical recording material comprising:

1) a two-photon absorbing compound capable of undergoing a two-photon absorption to produce an excited state upon irradiation with light having a wavelength that is longer than the linear absorption band of the compound 1) itself and has a molar absorption coefficient of linear absorption of 10 or less;

2) a dye precursor having an absorption shifted to the longer wavelength side than in the original state by electron or energy transfer from said two-photon absorbing compound 1) in the excited state to become a color-forming material having an absorption in the wavelength region where the molar absorption coefficient of linear absorption in the two-photon absorbing compound 1) is 5,000 or less;

3) a polymerization initiator capable of initiating a polymerization of a polymerizable compound by electron or energy transfer from said two-photon absorbing compound 1) in the excited state;

4) a polymerizable compound; and

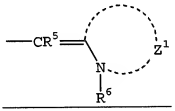
5) a binder,

wherein said two-photon absorbing compound is a cyanine dye, a merocyanine dye, an oxonol dye, a phthalocyanine dye or a compound represented by the following formula (1):

Formula (1):

$$X^2-\left(CR^4=CR^3\right)_m-\underset{\underset{O}{\|}}{C}-\left(CR^1=CR^2\right)_n-X^1$$

wherein R^1, R^2, R^3 and R^4 each independently represents a hydrogen atom or a substituent and some of R^1, R^2, R^3 and R^4 may combine with each other to form a ring; n and m each independently represents an integer of 0 to 4 and when n and m each is 2 or more, multiple R^1s, R^2s, R^3s or R^4s may be the same or different, provided that n and m are not 0 at the same time; and X^1 and X^2 each independently represents an aryl group, a heterocyclic group or a group represented by formula (2):



wherein R^5 represents a hydrogen atom or a substituent, R^6 represents a hydrogen atom, an alkyl group, an alkenyl group, an aryl group or a heterocyclic group, and Z^1 represents an atomic group for forming a 5- or 6-membered ring..

6. (currently amended): A two-photon absorbing optical recording method comprising: a first step of forming a latent image of a color-forming material containing a cationic or anionic polymerizable compound by a two-photon absorption; a second step of irradiating light on said latent image of a color-forming material to cause a polymerization based on a linear absorption of the color-forming material; and thereby forming difference in the refractive index to perform a recording, wherein the recording is performed by using the two-photon absorbing optical recording material described in claim 5.

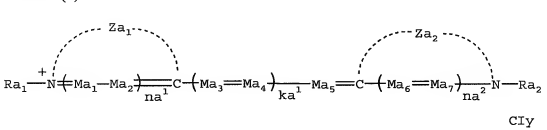
7. (original): The two-photon absorbing optical recording method as claimed in claim 6, wherein the wavelength of light for performing the formation of a latent image by two-photon absorption in the first step and the wavelength of light for causing a polymerization by the latent image in the second step are the same.

8. (original): The two-photon absorbing optical recording method as claimed in claim 6, wherein the wavelength of light for causing a polymerization by a latent image in the second step is shorter than the wavelength of light for performing the formation of the latent image by two-photon absorption in the first step, and is present in the wavelength region where the molar absorption coefficient of linear absorption in the two-photon absorbing compound is 5,000 or less.

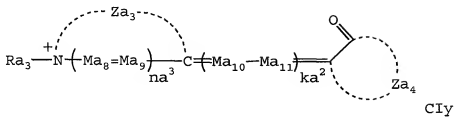
9. (canceled).

10. (currently amended): The two-photon absorbing polymerization method as claimed in claim 19, wherein the cyanine dye is represented by the following formula (3), the merocyanine dye is represented by formula (4) and the oxonol dye is represented by formula (5):

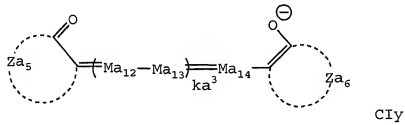
Formula (3):



Formula (4):



Formula (5):

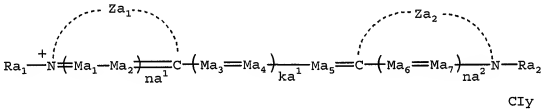


wherein Za_1, Za_2 and Za_3 each represents an atomic group for forming a 5- or 6-membered nitrogen-containing heterocyclic ring, Za_4, Za_5 and Za_6 each represents an atomic group for forming a 5- or 6-membered ring, Ra_1, Ra_2 and Ra_3 each independently represents a hydrogen atom, an alkyl group, an alkenyl group, an aryl group or a heterocyclic group, Ma_1 to Ma_{14} each independently represents a methine group which may have a substituent or may form a ring together with another methine group, na^1, na^2 and na^3 each represents 0 or 1, ka^1 and ka^3 each represents an integer of 0 to 3, provided that when ka^1 is 2 or more, multiple Ma_3s or Ma_4s may be the same or different and when ka^3 is 2 or more, multiple Ma_{12}s or Ma_{13}s may be the same or different, ka^2 represents an integer of 0 to 8, provided that when ka^2 is 2 or more, multiple Ma_{10}s or Ma_{11}s may be the same or different, CI represents an ion for neutralizing the electric charge, and y represents a number necessary for the neutralization of electric charge.

11. (canceled).

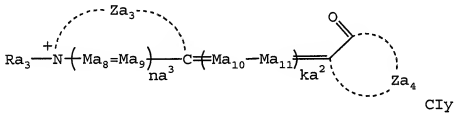
12. (currently amended): The two-photon absorbing optical recording method as claimed in claim 3~~11~~, wherein the cyanine dye is represented by the following formula (3), the merocyanine dye is represented by formula (4) and the oxonol dye is represented by formula (5):

Formula (3):



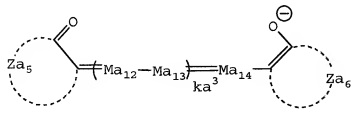
CIy

Formula (4):



CIy

Formula (5):



CIy

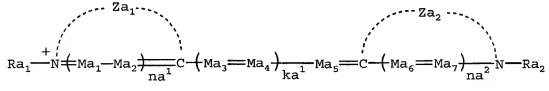
wherein Za_1, Za_2 and Za_3 each represents an atomic group for forming a 5- or 6-membered nitrogen-containing heterocyclic ring, Za_4, Za_5 and Za_6 each represents an atomic group for forming a 5- or 6-membered ring, Ra_1, Ra_2 and Ra_3 each independently represents a

hydrogen atom, an alkyl group, an alkenyl group, an aryl group or a heterocyclic group, Ma_1 to Ma_{14} each independently represents a methine group which may have a substituent or may form a ring together with another methine group, na^1, na^2 and na^3 each represents 0 or 1, ka^1 and ka^3 each represents an integer of 0 to 3, provided that when ka^1 is 2 or more, multiple Ma_3s or Ma_4s may be the same or different and when ka^3 is 2 or more, multiple Ma_{12}s or Ma_{13}s may be the same or different, ka^2 represents an integer of 0 to 8, provided that when ka^2 is 2 or more, multiple Ma_{10}s or Ma_{11}s may be the same or different, CI represents an ion for neutralizing the electric charge, and y represents a number necessary for the neutralization of electric charge.

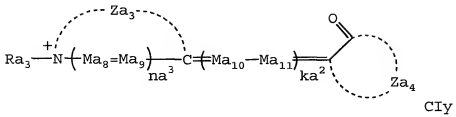
13. (canceled).

14. (currently amended): The two-photon absorbing optical recording material as claimed in claim ~~13~~ 5, wherein the cyanine dye is represented by the following formula (3), the merocyanine dye is represented by formula (4) and the oxonol dye is represented by formula (5):

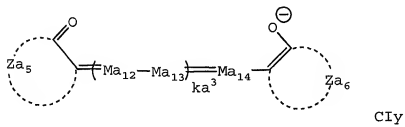
Formula (3):



Formula (4):



Formula (5):



wherein Za_1, Za_2 and Za_3 each represents an atomic group for forming a 5- or 6-membered nitrogen-containing heterocyclic ring, Za_4, Za_5 and Za_6 each represents an atomic group for forming a 5- or 6-membered ring, Ra_1, Ra_2 and Ra_3 each independently represents a hydrogen atom, an alkyl group, an alkenyl group, an aryl group or a heterocyclic group, Ma_1 to Ma_{14} each independently represents a methine group which may have a substituent or may form a ring together with another methine group, na^1, na^2 and na^3 each represents 0 or 1, ka^1 and ka^3 each represents an integer of 0 to 3, provided that when ka^1 is 2 or more, multiple Ma_3s or Ma_4s may be the same or different and when ka^3 is 2 or more, multiple Ma_{12}s or Ma_{13}s may be the same or different, ka^2 represents an integer of 0 to 8, provided that when ka^2 is 2 or more, multiple Ma_{10}s or Ma_{11}s may be the same or different, CI represents an ion for neutralizing the electric charge, and y represents a number necessary for the neutralization of electric charge.

15. (currently amended): A two photon absorbing optical recording and ~~reproducing~~reproduction method comprising: performing a recording by the first and second steps described in claim 3; then performing a reproduction by irradiating light on said recorded area and detecting the difference in reflectance attributable to the difference in refractive index.

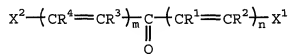
16. (original): The two-photon absorbing optical recording method as claimed in claim 6, wherein the polymerizable compound and the binder have a difference in the refractive index, and the compositional ratio of the polymerizable compound and a polymerization reaction product thereof to the binder becomes non-uniform between the recorded area and the unrecorded area to enable a two-photon absorbing optical recording by utilizing a modulation of refractive index.

17. (original): The two-photon absorbing optical recording material as claimed in claim 5, wherein the polymerizable compound contains at least one selected from the group consisting of an aryl group, an aromatic heterocyclic group, a chlorine atom, a bromine atom, an iodine atom and a sulfur atom, and the binder has a refractive index lower than that of the polymerizable compound.

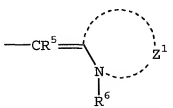
18. (original): The two-photon absorbing optical recording material as claimed in claim 5, wherein the dye precursor is an acid-color forming dye precursor or a base-color forming dye precursor.

19. (previously presented): A two-photon absorbing polymerizable composition comprising a two-photon absorbing compound, a polymerization initiator, a polymerizable compound and a binder, in which the two-photon absorbing polymerizable composition is capable of generating a three-dimensional modulation of refractive index as a result of photo-polymerization caused by non-resonant two-photon absorption,

wherein said two-photon absorbing compound is a methine dye, a cyanine dye, a merocyanine dye, an oxonol dye, a phthalocyanine dye or a compound represented by the following formula (1):



wherein R^1, R^2, R^3 and R^4 each independently represents a hydrogen atom or a substituent and some of R^1, R^2, R^3 and R^4 may combine with each other to form a ring; n and m each independently represents an integer of 0 to 4 and when n and m each is 2 or more, multiple R^1s, R^2s, R^3s or R^4s may be the same or different, provided that n and m are not 0 at the same time; and X^1 and X^2 each independently represents an aryl group, a heterocyclic group or a group represented by formula (2):



wherein R^5 represents a hydrogen atom or a substituent, R^6 represents a hydrogen atom, an alkyl group, an alkenyl group, an aryl group or a heterocyclic group, and Z^1 represents an atomic group for forming a 5- or 6-membered ring.

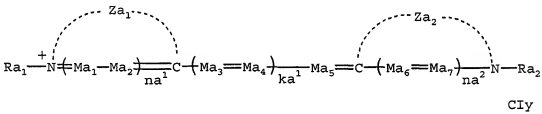
20. (currently amended): A two photon ~~absorbing optical~~ recording process and ~~reproducing~~reproduction method comprising: performing a recording by using the two-photon absorbing polymerizable composition described in claim 19; then performing a reproduction by irradiating light on said recorded area and detecting the difference in reflectance attributable to the difference in refractive index.

21. (original): The two-photon absorbing polymerizable composition as claimed in claim 19, wherein the polymerizable compound and the binder have a difference in the refractive index, and the compositional ratio of the polymerizable compound and a polymerization reaction product thereof to the binder becomes non-uniform between the recorded area and the unrecorded area to enable a two-photon absorbing optical recording by utilizing a modulation of refractive index.

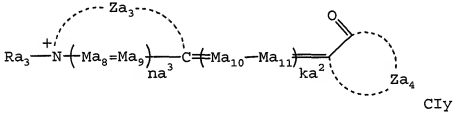
22-23. (canceled).

24. (previously presented): The two-photon absorbing polymerizable composition as claimed in claim 19, wherein the cyanine dye is represented by the following formula (3), the merocyanine dye is represented by formula (4) and the oxonol dye is represented by formula (5):

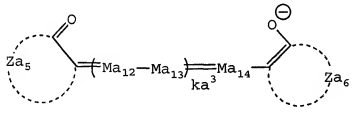
Formula (3):



Formula (4):



Formula (5):



wherein Za_1, Za_2 and Za_3 each represents an atomic group for forming a 5- or 6-membered nitrogen-containing heterocyclic ring, Za_4, Za_5 and Za_6 each represents an atomic group for forming a 5- or 6-membered ring, Ra_1, Ra_2 and Ra_3 each independently represents a hydrogen atom, an alkyl group, an alkenyl group, an aryl group or a heterocyclic group, Ma_1 to Ma_{14} each independently represents a methine group which may have a substituent or may form

a ring together with another methine group, na^1, na^2 and na^3 each represents 0 or 1, ka^1 and ka^3 each represents an integer of 0 to 3, provided that when ka^1 is 2 or more, multiple Ma_3s or Ma_4s may be the same or different and when ka^3 is 2 or more, multiple Ma_{12}s or Ma_{13}s may be the same or different, ka^2 represents an integer of 0 to 8, provided that when ka^2 is 2 or more, multiple Ma_{10}s or Ma_{11}s may be the same or different, CI represents an ion for neutralizing the electric charge, and y represents a number necessary for the neutralization of electric charge.

25. (original): A method for three-dimensionally modulating a refractive index, comprising: irradiating the two-photon absorbing polymerizable composition described in claim 19 with laser light at a wavelength being longer than the linear absorption band of the two-photon absorbing compound and having no linear absorption to induce a two-photon absorption; and causing photopolymerization by utilizing the two-photon absorption induced.

26. (original): A three-dimensional optical recording method comprising:

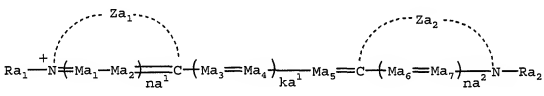
irradiating the two-photon absorbing polymerizable composition described in claim 19 with laser light at a wavelength being longer than the linear absorption band of the two-photon absorbing compound and having no linear absorption to induce a two-photon absorption;

causing photopolymerization by utilizing the two-photon absorption induced to cause a non-uniformity of the compositional ratio of the polymerizable compound and a polymerization reaction product thereof to the binder between the laser-focused area and unfocused area; and

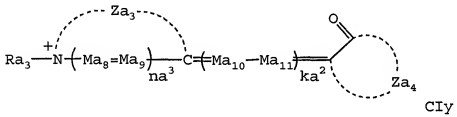
performing a recording by using a three-dimensional modulation of refractive index caused by the non-uniformity of the compositional ratio.

27. (new): The two-photon absorbing polymerization method as claimed in claim 2, wherein the cyanine dye is represented by the following formula (3), the merocyanine dye is represented by formula (4) and the oxonol dye is represented by formula (5):

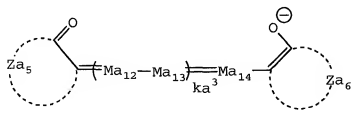
Formula (3):



Formula (4):



Formula (5):



wherein Za_1, Za_2 and Za_3 each represents an atomic group for forming a 5- or 6-membered nitrogen-containing heterocyclic ring, Za_4, Za_5 and Za_6 each represents an atomic

group for forming a 5- or 6-membered ring, Ra_1, Ra_2 and Ra_3 each independently represents a hydrogen atom, an alkyl group, an alkenyl group, an aryl group or a heterocyclic group, Ma_1 to Ma_{14} each independently represents a methine group which may have a substituent or may form a ring together with another methine group, na^1, na^2 and na^3 each represents 0 or 1, ka^1 and ka^3 each represents an integer of 0 to 3, provided that when ka^1 is 2 or more, multiple Ma_3s or Ma_4s may be the same or different and when ka^3 is 2 or more, multiple Ma_{12}s or Ma_{13}s may be the same or different, ka^2 represents an integer of 0 to 8, provided that when ka^2 is 2 or more, multiple Ma_{10}s or Ma_{11}s may be the same or different, CI represents an ion for neutralizing the electric charge, and y represents a number necessary for the neutralization of electric charge.